CERoPath

Community Ecology of Rodents and their Pathogens in South-East Asia
Effects of biodiversity changes and implications in health ecology

Rodents and their parasites: various patterns associated with anthropogenic disturbances

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Session 2 – Mammals and their parasites, July, 22nd 2011

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Community Ecology of Rodents and their Pathogens in South-East Asia
Effects of biodiversity changes and implications in health ecology

Background

CERoPath project (ANR 07 BDIV 012) **:**

Community **E**cology of **Ro**dents and their **Path**ogens in South-East Asia

www.ceropath.org

→ aiming at understanding the implication of rodents in the transmission of diseases,

→ in a context of rapid environmental changes.

Photos: Herbreteau V.

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Introduction

Human pressure on the environment

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Deforestation in Thailand:

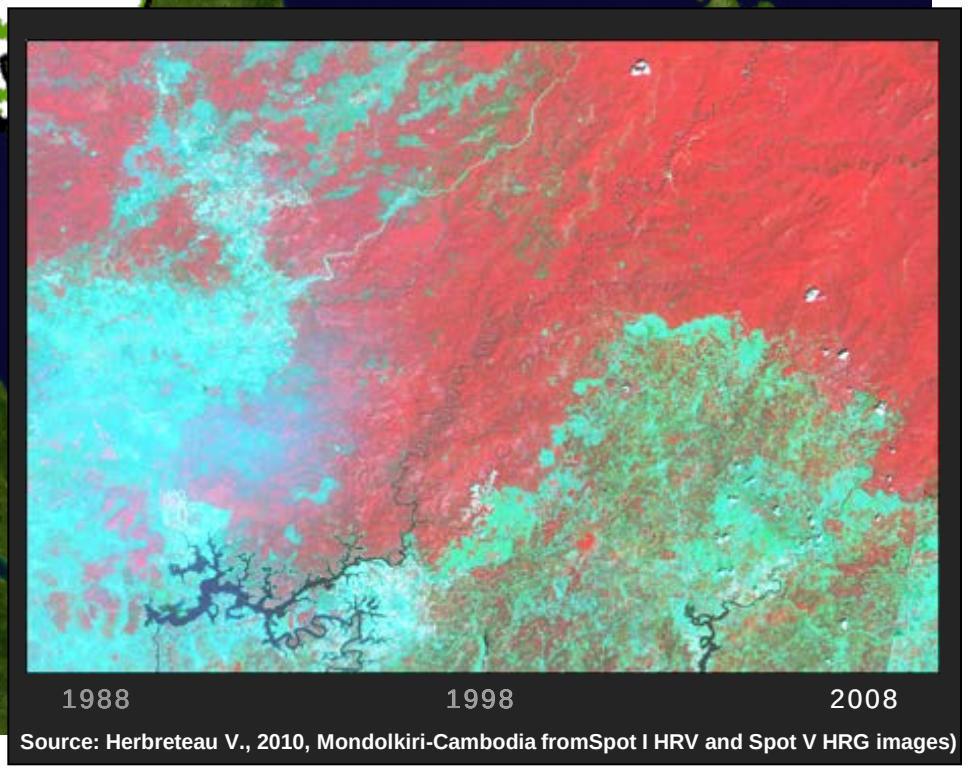
1840 (estimated)

1950

1990

Deforestation in Cambodia:

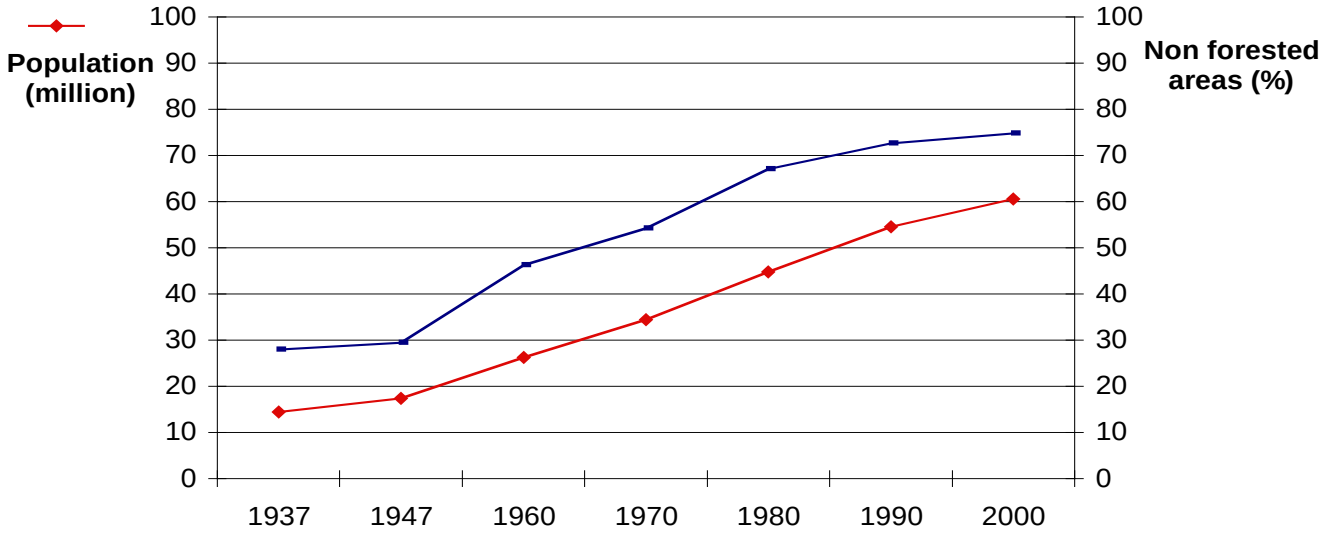
an ongoing process



Source: Herbreteau V., 2010, Mondolkiri-Cambodia fromSpot I HRV and Spot V HRG images)

Introduction

Human pressure on the environment



Parallel increase of population (◆) and non forested areas (▭), between 1937 and 2000, in Thailand
(Sources: National Statistical Office, Royal Forest Department)


Photo: Janeau JL


Photo: Janeau JL


Photo: Herbreteau V

Introduction

Human pressure on the environment

- High hunting pressure:

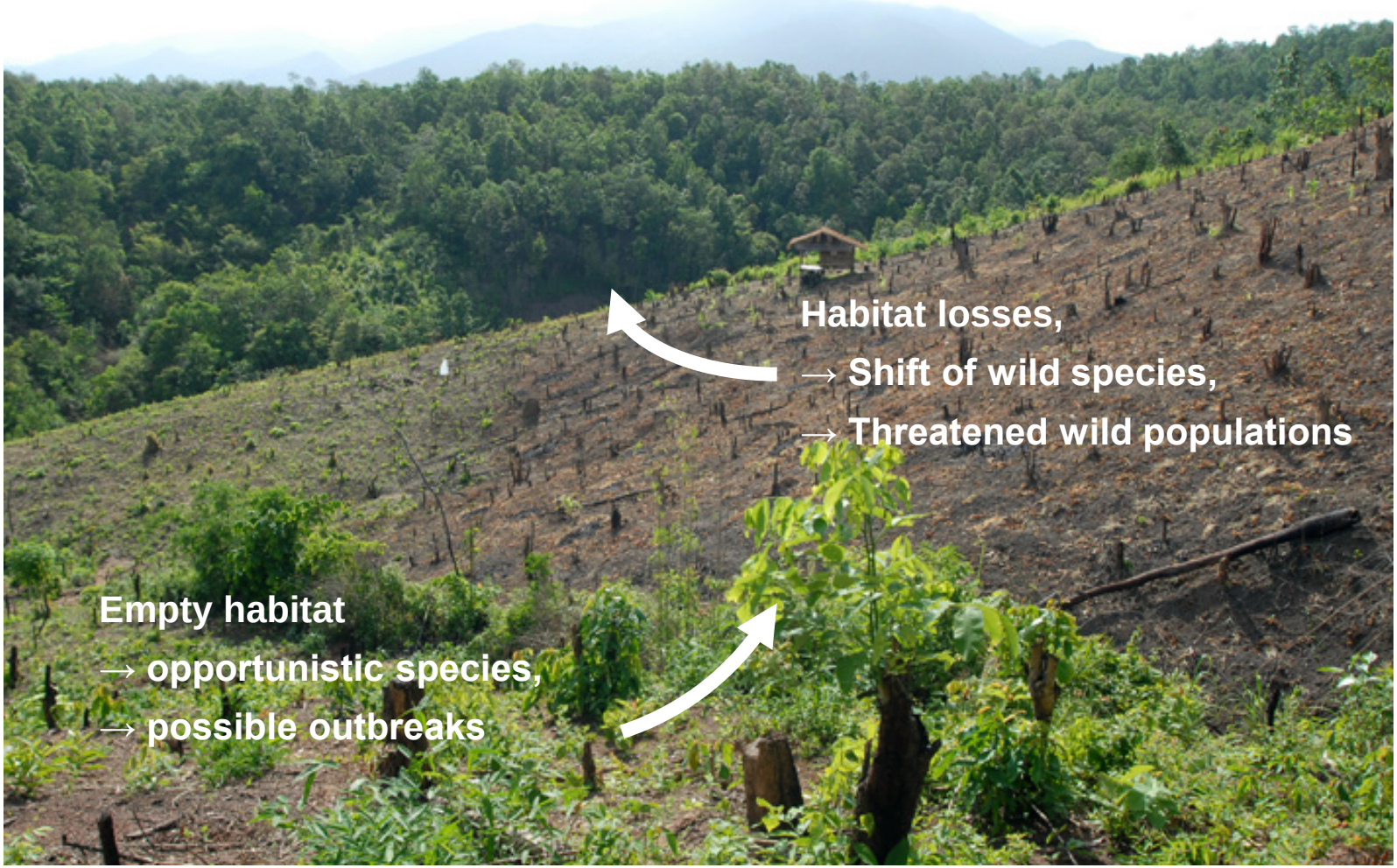
  → very low densities of wild species, many species threatened.

  → Rodents are the main wild mammals.

Introduction

Environmental changes and rodent-parasites dynamics

- How could rodent populations face these changes?



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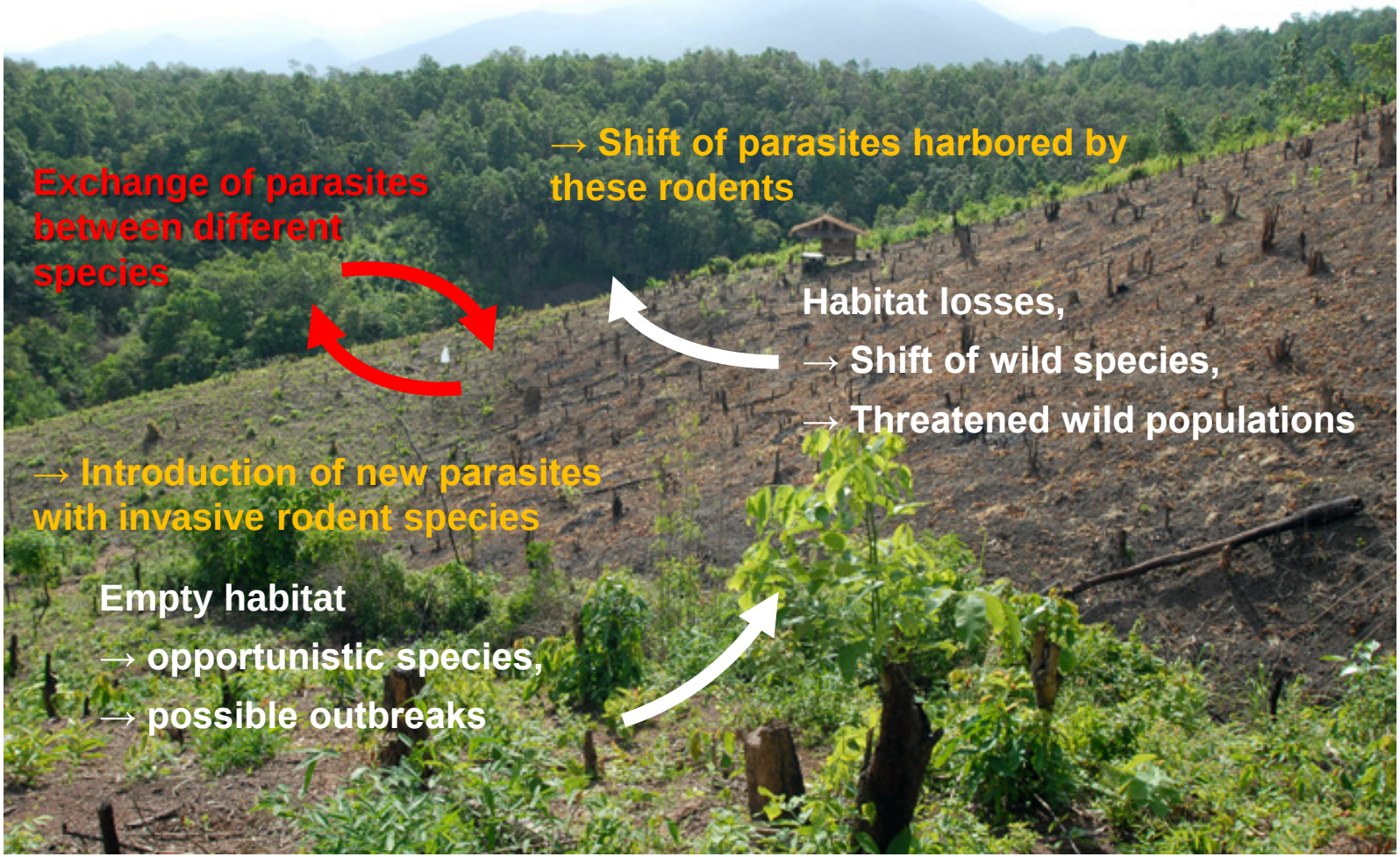
Introduction

Environmental changes and rodent-parasites dynamics

- What could be the consequences for parasites dynamics?



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Introduction:

Emergence of rodent-borne diseases in Thailand

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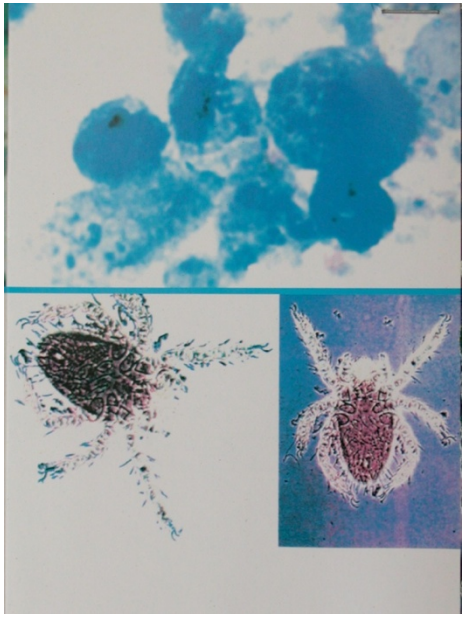
• Emergence of two bacterial diseases with rats as a major vector:

- scrub typhus
- leptospirosis



Thai information booklet about leptospirosis

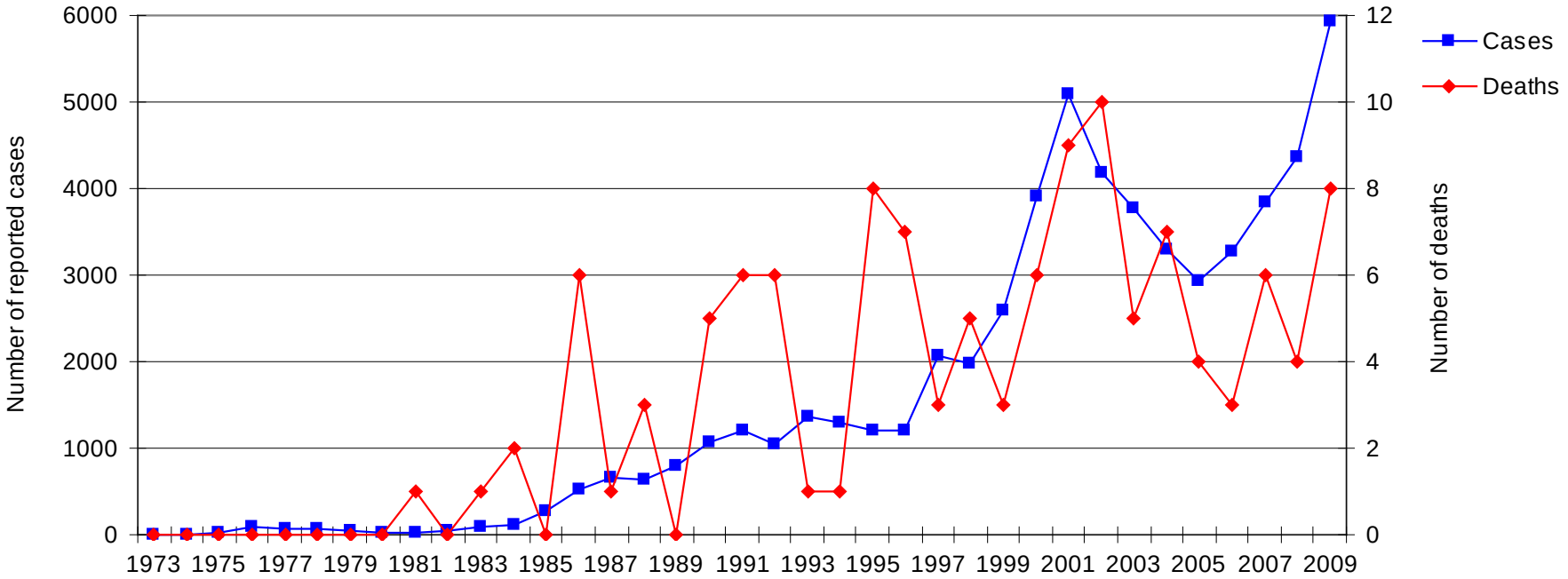
→ Two pathologies diagnosed and reported by the health system in Thailand.

→ Unknown situation for other pathogens and in neighbouring countries.

Introduction:

Emergence of rodent-borne diseases in Thailand

- Scrub typhus emergence since the 80's



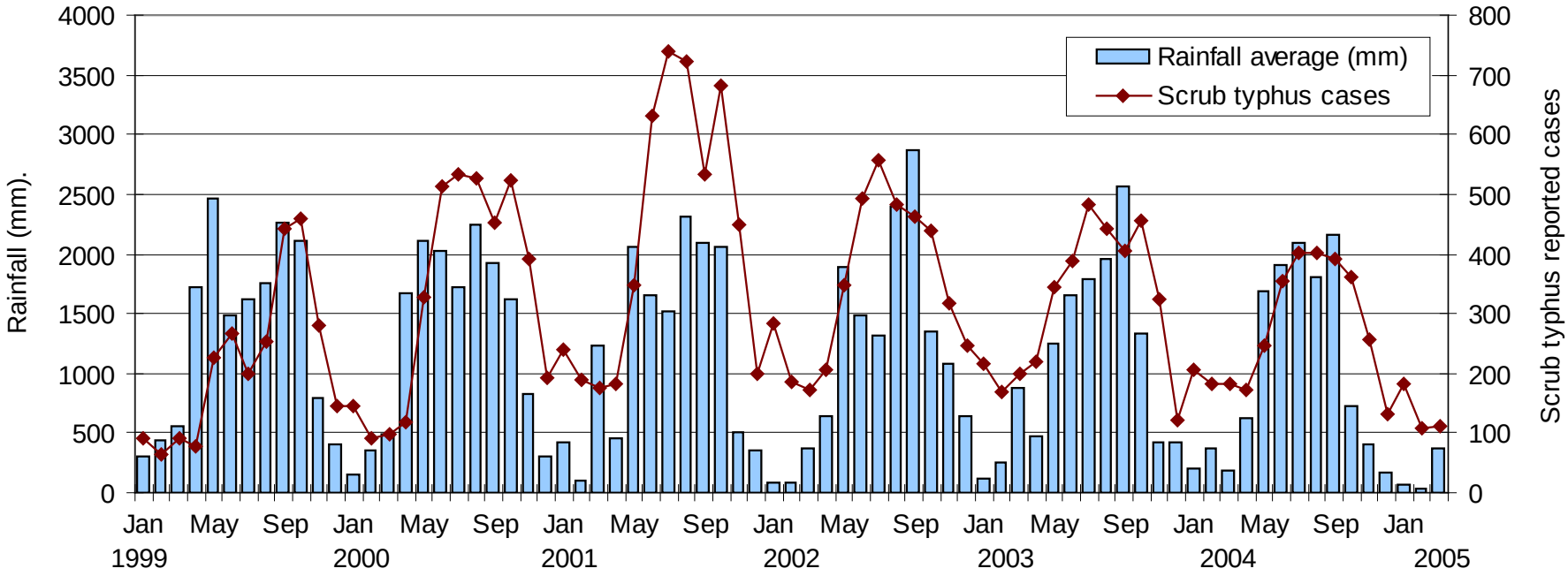
Number of scrub typhus reported cases and deaths in Thailand, from 1973 to 2009

(Source : Ministry of Public Health, 2010)

Introduction:

Emergence of rodent-borne diseases in Thailand

- Scrub typhus emergence since the 80's



Monthly reported cases of scrub typhus and average rainfall in Thailand, from 1999 to 2005

(Source: Ministry of Public Health, Thai Meteorological Department 2007)

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Introduction:

Emergence of rodent-borne diseases in Thailand

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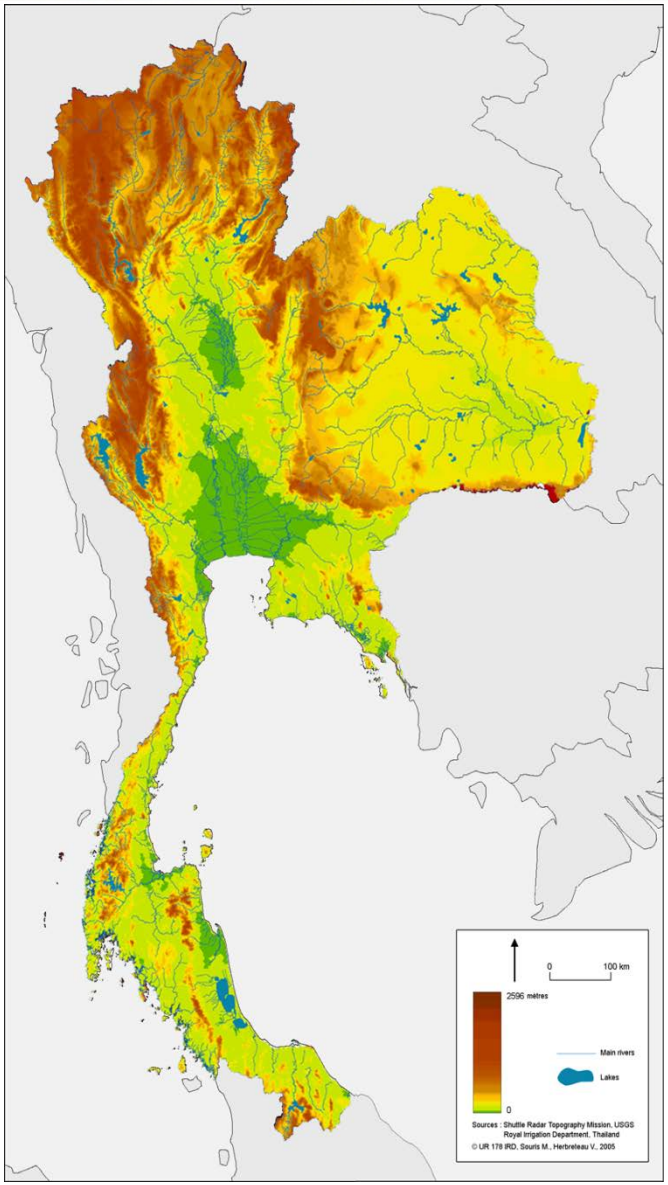
• Scrub typhus spatio-temporal distribution is linked to

- the physical geography



Scrub typhus average Incidence,
from January 2000 to December 2004
(/100,000 inhabitants)

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Introduction:

Emergence of rodent-borne diseases in Thailand

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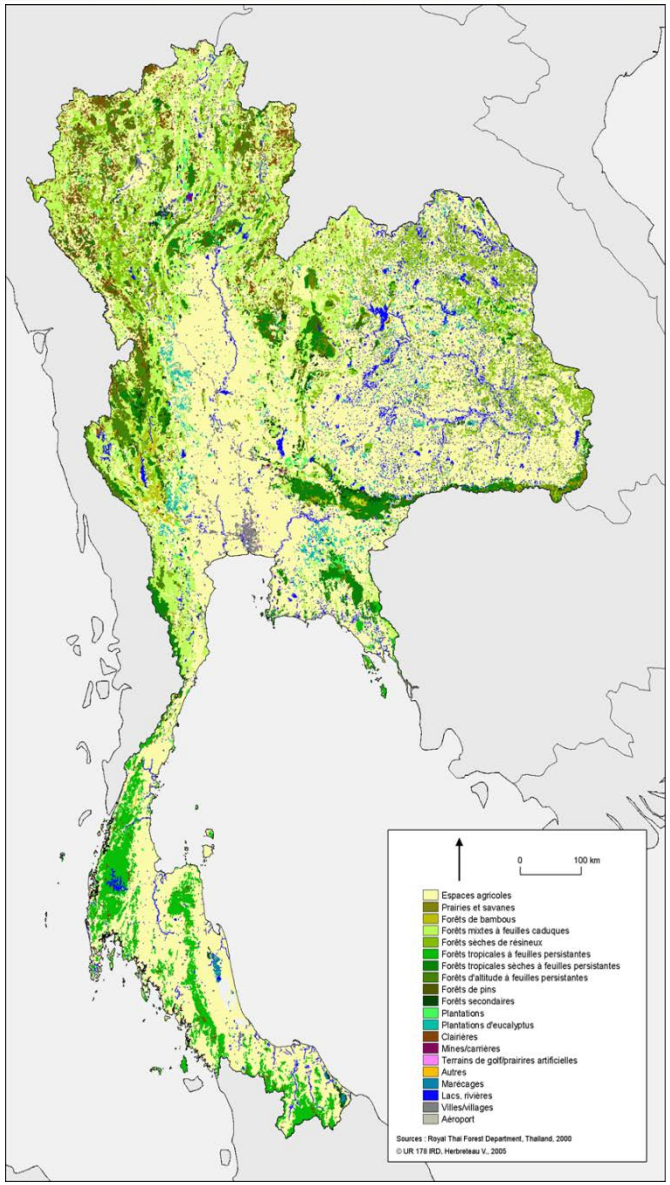
• Scrub typhus spatio-temporal distribution is linked to

- the physical geography,

- land cover changes.

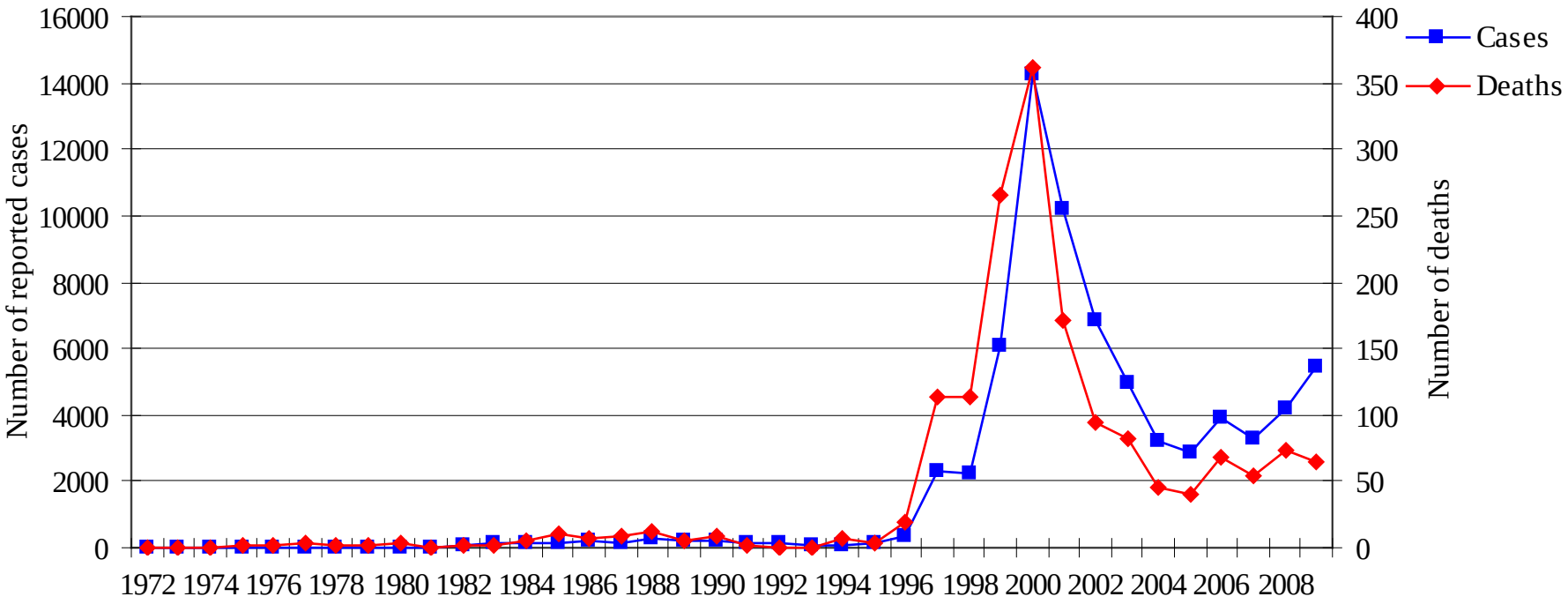


Scrub typhus average Incidence,
from January 2000 to December 2004
(/100,000 inhabitants)

Introduction:

Emergence of rodent-borne diseases in Thailand

- Leptospirosis emergence since 1996



Number of leptospirosis cases and deaths reported in Thailand, from 1972 to 2009

(Source : Ministry of Public Health, 2010)

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Introduction:

Emergence of rodent-borne diseases in Thailand

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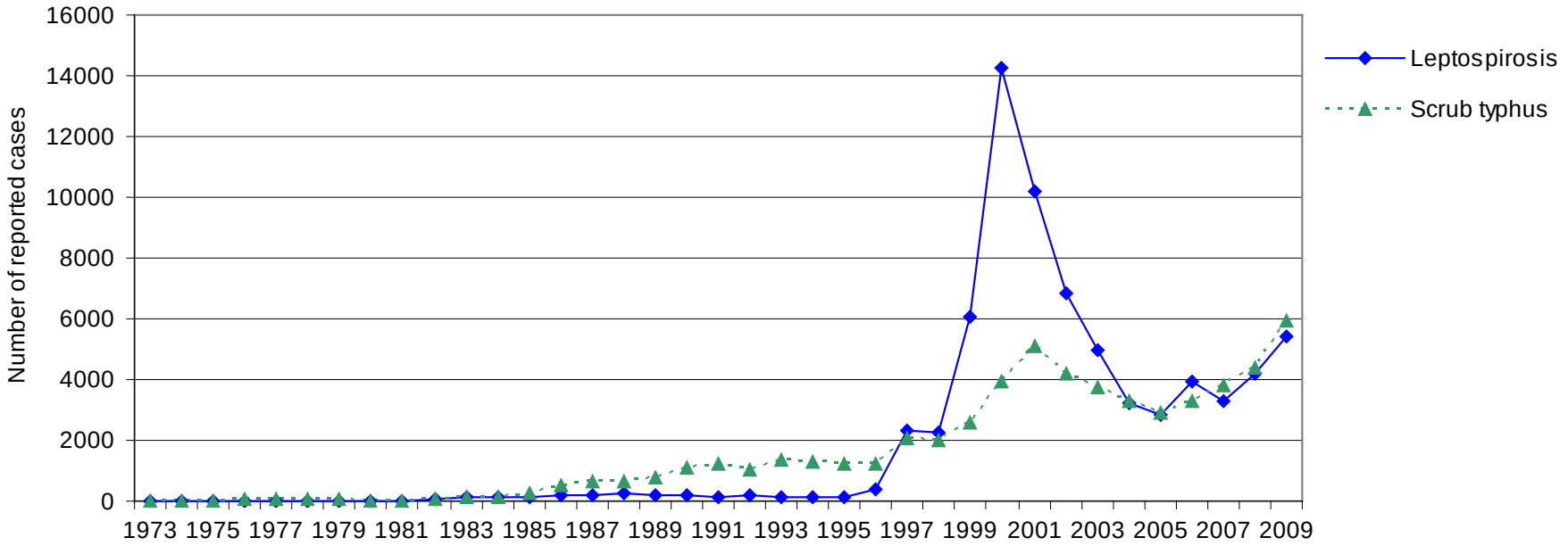
- Leptospirosis emergence since 1996: comparison with scrub typhus emergence



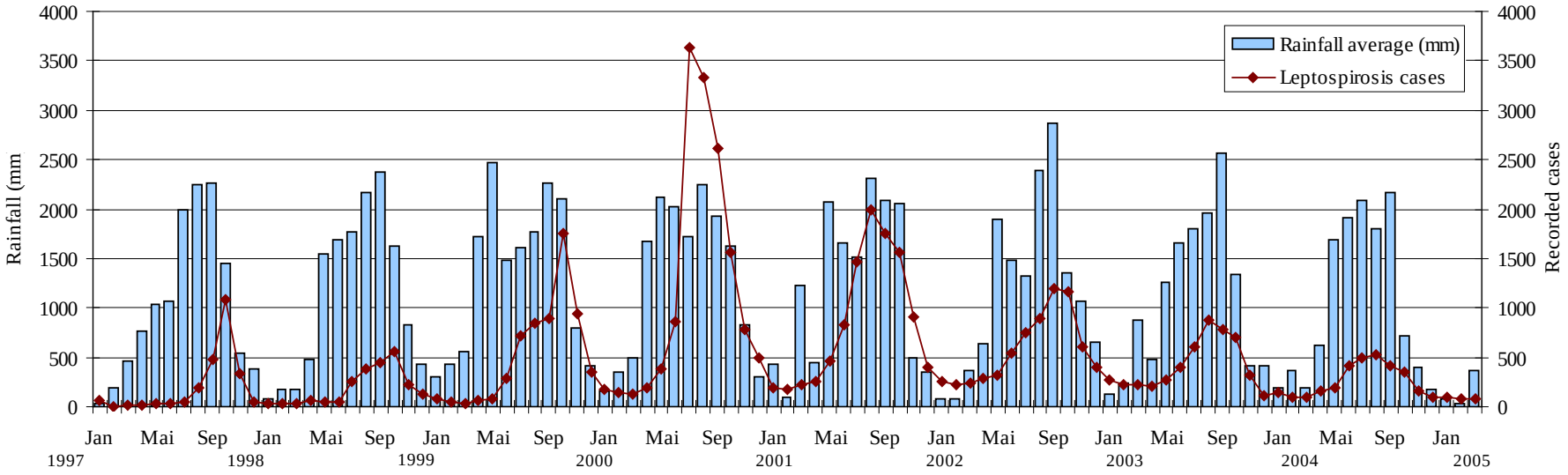
Number of leptospirosis and scrub typhus cases reported in Thailand, from 1973 to 2009

(Source : Ministry of Public Health, 2010)

Introduction:

Emergence of rodent-borne diseases in Thailand

- Leptospirosis emergence since 1996



Monthly reported cases of leptospirosis and average rainfall in Thailand, from 1999 to 2005

(Source: Ministry of Public Health, Thai Meteorological Department 2007)

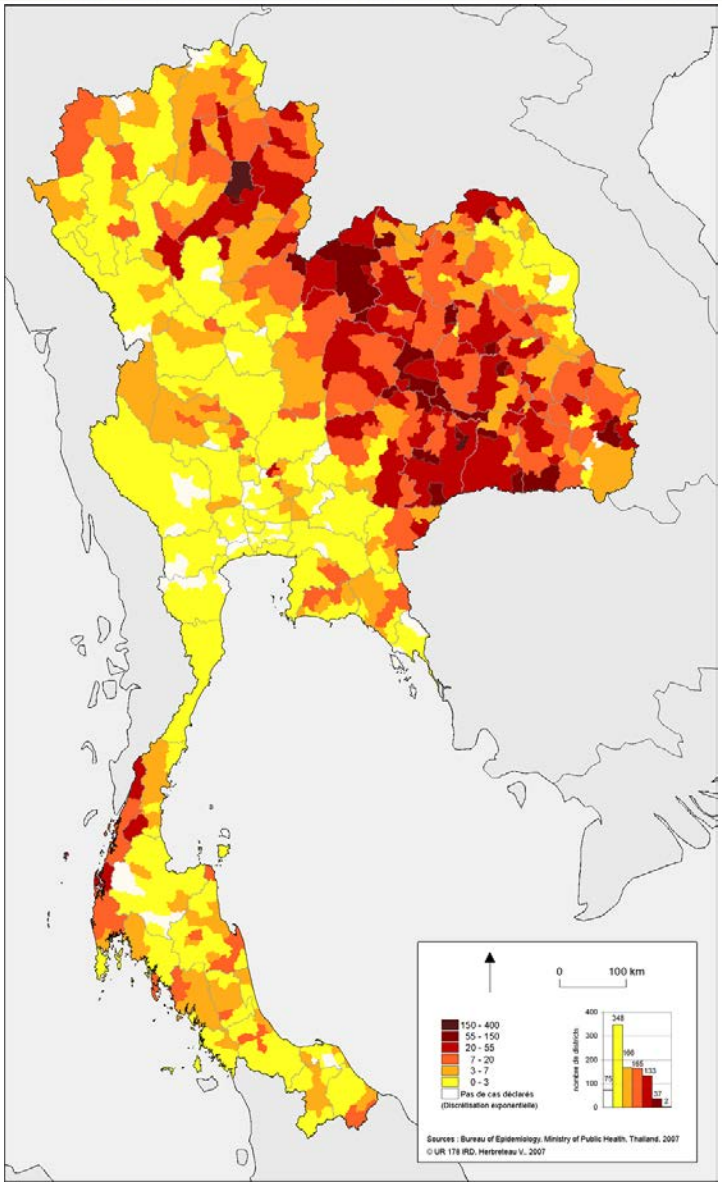
CERoPath

Introduction:

Emergence of rodent-borne diseases in Thailand

- Leptospirosis spatio-temporal distribution is not linked to the physical geography and the land cover changes
- Leptospirosis spatio-temporal distribution is not linked to the distribution of rodent species

→ the geography of leptospirosis is dependant of the vulnerability of populations



Leptospirosis average Incidence,
from January 2000 to December 2006
(/100,000 inhabitants)

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Introduction:

Emergence of rodent-borne diseases in Thailand

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- Awareness about the emergence of diseases from rodents

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Introduction:

Increasing surveys of parasites in rodents

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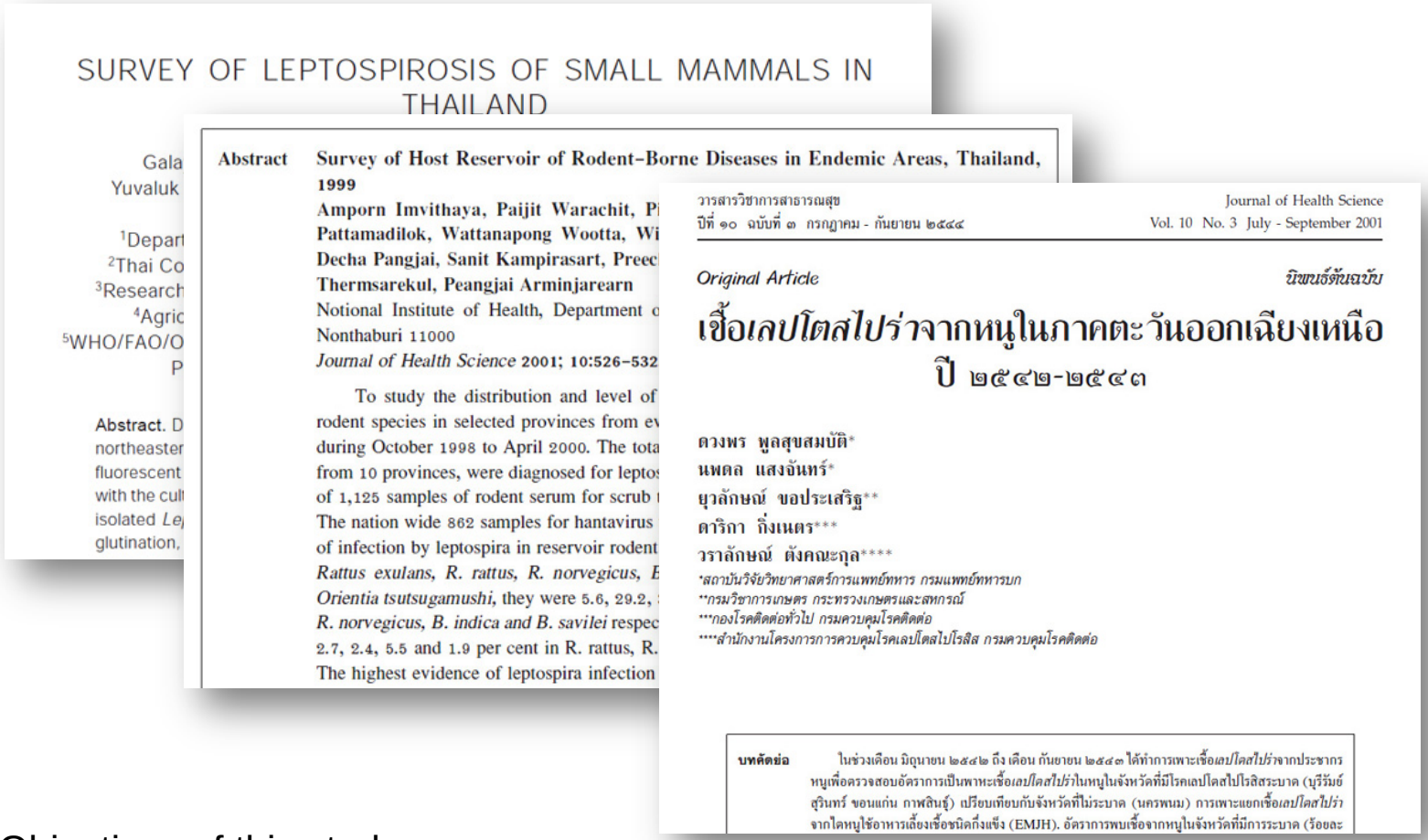

SURVEY OF LEPTOSPIROSIS OF SMALL MAMMALS IN THAILAND

Gala
Yuvaluk

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[2]Thai Co
[3]Research
[4]Agric
[5]WHO/FAO/O
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Abstract. D
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Abstract **Survey of Host Reservoir of Rodent-Borne Diseases in Endemic Areas, Thailand, 1999**

**Amporn Imvithaya, Paijit Warachit, Pi
Pattamadilok, Wattanapong Wootta, Wi
Decha Pangjai, Sanit Kampirasart, Preec
Thermsarekul, Peangjai Arminjarearn**

Notional Institute of Health, Department o
Nonthaburi 11000

Journal of Health Science 2001; 10:526-532

To study the distribution and level of
rodent species in selected provinces from ev
during October 1998 to April 2000. The tota
from 10 provinces, were diagnosed for leptos
of 1,125 samples of rodent serum for scrub
The nation wide 862 samples for hantavirus
of infection by leptospira in reservoir rodent
*Rattus exulans, R. rattus, R. norvegicus, B
Orientia tsutsugamushi,* they were 5.6, 29.2,
R. norvegicus, B. indica and B. savilei respec
2.7, 2.4, 5.5 and 1.9 per cent in R. rattus, R.
The highest evidence of leptospira infection

วารสารวิชาการสาธารณสุข
ปีที่ ๑๐ ฉบับที่ ๓ กรกฎาคม - กันยายน ๒๕๔๔

Journal of Health Science
Vol. 10 No. 3 July - September 2001

Original Article

นิพนธ์ต้นฉบับ

เชื้อเลปโตสไปร่าจากหนูในภาคตะวันออกเฉียงเหนือ ปี ๒๕๔๒-๒๕๔๓

ดวงพร พูลสุขสมบัติ*
นพดล แสงจันทร์*
ยุวลักษณ์ ขอประเสริฐ**
ดาริกา กิ่งเนตร***
วราลักษณ์ ตังคณะกุล****

บทคัดย่อ ในช่วงเดือน มิถุนายน ๒๕๔๒ ถึง เดือน กันยายน ๒๕๔๓ ได้ทำการเพาะเชื้อ*เลปโตสไปร่า*จากประชากรหนูเพื่อตรวจสอบอัตราการเป็นพาหะเชื้อ*เลปโตสไปร่า*ในหนูในจังหวัดที่มีโรคเลปโตสไปโรสิสระบาด (บุรีรัมย์ สุรินทร์ ขอนแก่น กาฬสินธุ์) เปรียบเทียบกับจังหวัดที่ไม่ระบาด (นครพนม) การเพาะแยกเชื้อ*เลปโตสไปร่า*จากไตหนูใช้อาหารเลี้ยงเชื้อชนิดกึ่งแข็ง (EMJH). อัตราการพบเชื้อจากหนูในจังหวัดที่มีการระบาด (ร้อยละ

Objectives of this study:

→ Review all the surveys of microparasites in rodents.

→ Possibly complete these investigations.

Material and Methods:

Literature review

Literature review of scientific articles and conference proceedings:

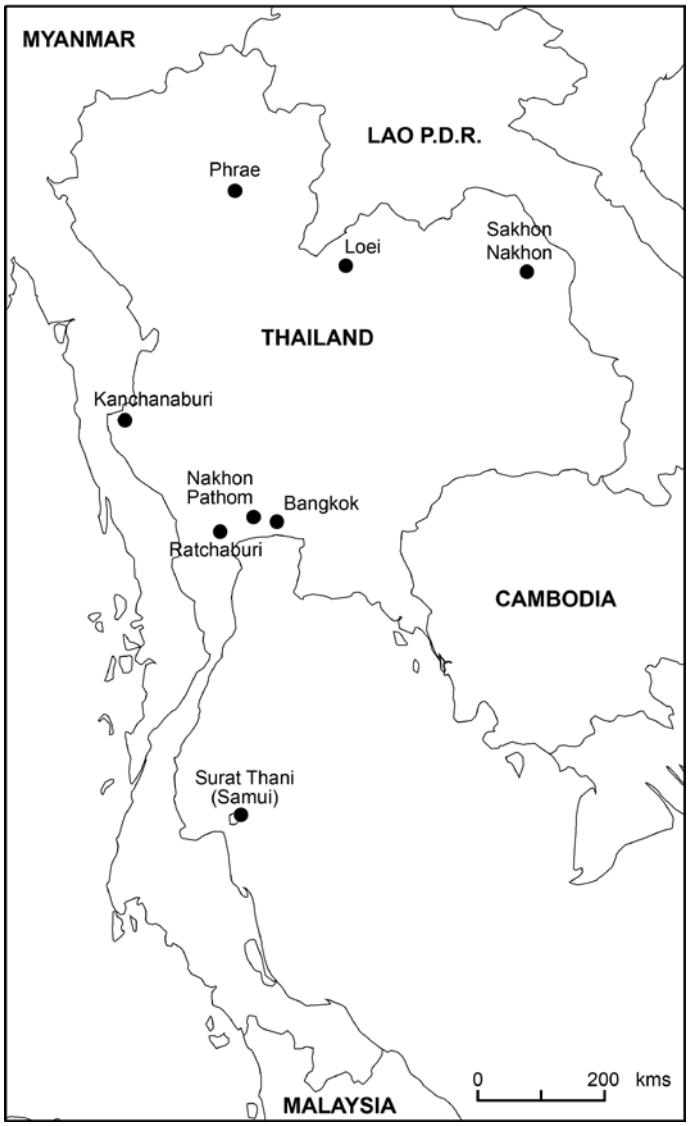
- dealing with the investigation of microparasites in murine rodents in Thailand.
- Published in English or in Thai.
- Search with internet search engines, journal websites, articles references.

Material and Methods:

Rodent sampling

Complementary rodent sampling:

- Different sites throughout Thailand.
- Use of locally made live-traps.
- Following CERoPath “Protocols for field and laboratory rodent studies” (In Press).

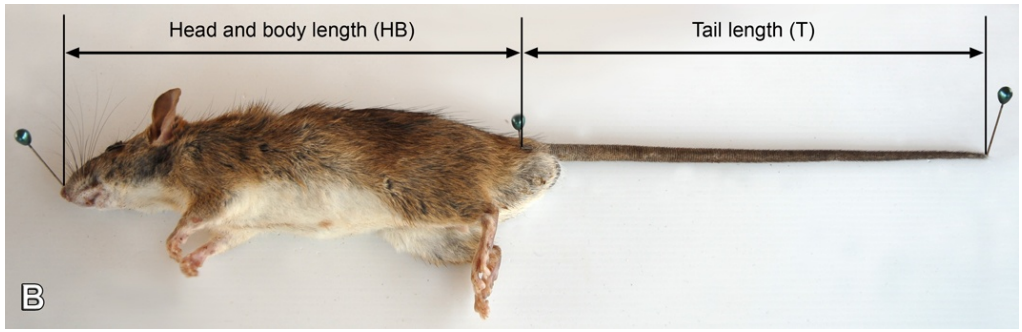


Material and Methods:

Rodent sampling

Rodent identification:

- Field identification: external measurements and description.
- Validation with genetic identification / CBGP-Montpellier (See Pagès et al., 2010; Chaval et al., 2010)



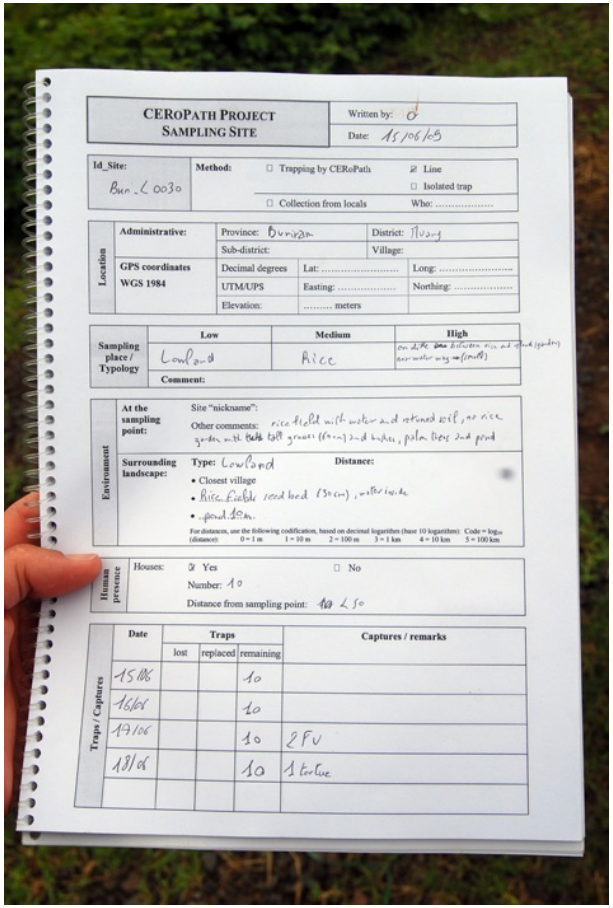
Material and Methods:

Rodent sampling

Environmental description:

- GPS locatisation of each sample.
- Description of the surrounding environment: landuse, distance to main landscape features, human presence, etc.
- Species habitat were ranked according to the degree of human habitat use (anthropization) (See Jittapalapong *et al.* (2008 and 2010)
  - Rank 1: forested areas.
  - Rank 2: fields near forests.
  - Rank 3: dry fields.
  - Rank 4: wet rice fields.
  - Rank 5: human settlements.

Increasing gradient of anthropogenic use and disturbance



Results:

Litterature review

• Literature synthesis of journal articles on microparasites investigations in rodents, in Thailand:

- Bacteria:
  - Leptospira: 9 articles,
  - Bartonella: 1 article,
  - Orientia: 2 articles.

- Viruses:
  - Hantavirus: 6 articles,
  - Hepatitis E virus: 1 conference proceeding,
  - Lymphocytic Choriomeningitis virus (LCMV): 1 article,
  - Rabies virus: 1 article.

- Blood parasites:
  - Trypanosoma: 2 articles,
  - Babesia: 1 article,
  - Hepatozoon: 1 article,
  - Haemaphysalis: 1 article,

  - Toxoplasma: 1 article

Results:

Litterature review

• Cumulated microparasites surveys in murine rodents in Thailand :

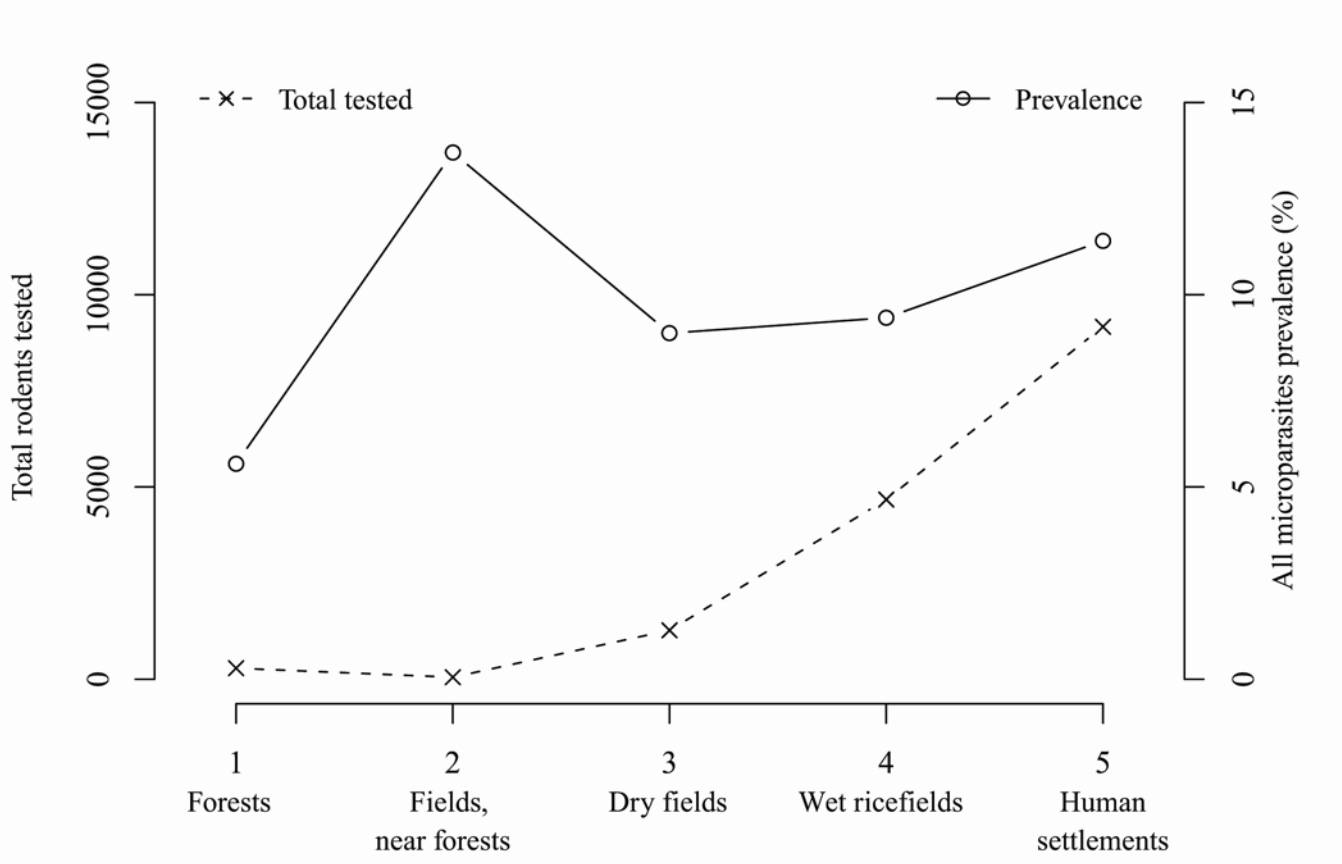
Species	**Total investigations**	
	%	Nb positive / total tested
Bandicota indica	**9.4**	**334 / 3,558**
Bandicota savilei	**9.2**	**89 / 966**
Berylmys berdmorei	**17.9**	**7 / 39**
Berylmys bowersi	0.0	0 / 12
Leopoldamys edwardsi	**12.1**	**4 / 33**
Maxomys surifer	**4.2**	**9 / 214**
Mus caroli	**0.0**	**0 / 95**
Mus cervicolor	**2.0**	**1 / 50**
Mus cookii	0.0	0 / 17
Mus musculus	0.0	0 / 9
Niviventer sp.	4.3	1 / 23
Rattus andamanensis	12.5	2 / 16
Rattus argentiventer	**9.9**	**27 / 272**
Rattus exulans	**4.4**	**110 / 2,525**
Rattus losea	**10.8**	**91 / 845**
Rattus norvegicus	**19.5**	**255 / 1,308**
Rattus tanezumi	**12.8**	**684 / 5,350**
Rattus tiomanicus	**12.9**	**26 / 202**
Total	**10.6**	**1,640 / 15,534**

Results:

Litterature review

- Cumulated microparasites surveys in murine rodents in Thailand :

  - Sampling bias / habitat:



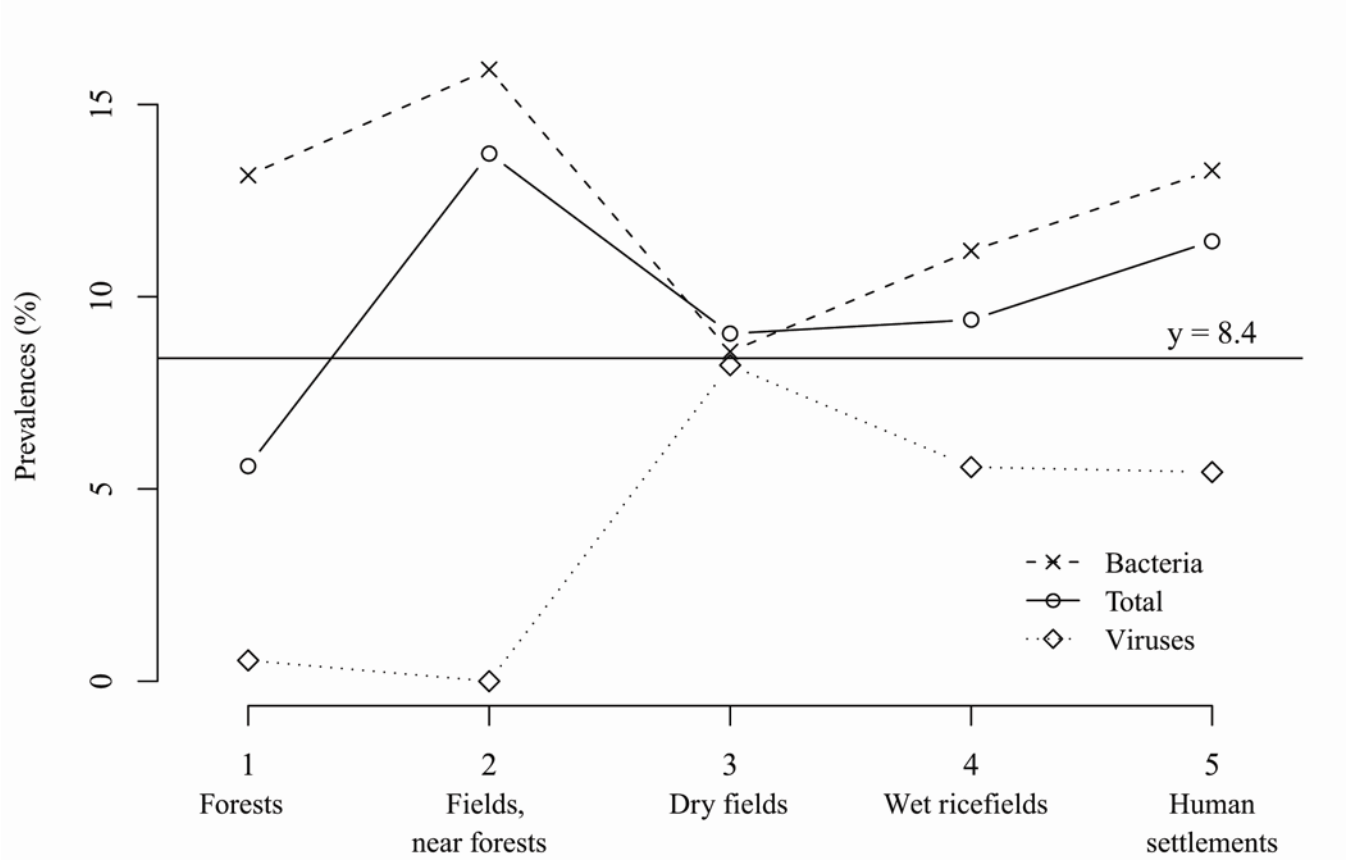
Prevalence of microparasites (solid line) and number of murine rodents tested (dashed line) in relation to a gradient of anthropization in habitats

Results:

Litterature review

- Cumulated microparasites surveys in murine rodents in Thailand :

  - Prevalences / anthropization :



Comparison of all microparasites prevalence (solid line), bacteria prevalence (dashed line) and viruses prevalence (dotted line) in relation to a gradient of anthropization in habitats

Results:

Litterature review

• Cumulated microparasites surveys in murine rodents in Thailand :

- Statistical analysis:

Correlations between:

microparasites prevalence by species / log-transformed body weight (0.617, $p<0.05$).

microparasite species richness / anthropization index (0.468, $p<0.05$).

Multiple linear regression models:

microparasites richness (idem for prevalence) predicted by:
log-transformed body weight + sampling effort index

→ ***Anthropization and host body weight matter.***

→ ***Higher risk of virus transmission from rodents living close to humans.***

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Results:

Litterature review

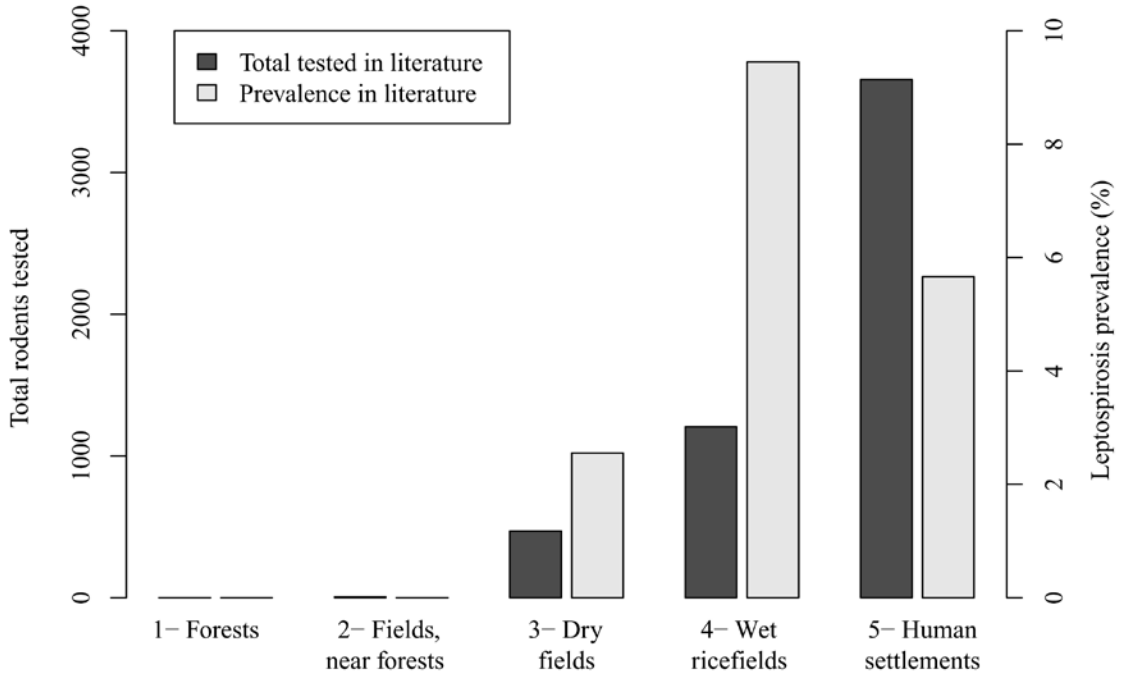
- Cumulated leptospirosis surveys in murine rodents in Thailand:

Species	**Leptospirosis**	
	%	Nb positive / total tested
Bandicota indica	**10.1 %**	**102 / 1,006**
Bandicota savilei	**2.6 %**	**12 / 464**
Berylmys berdmorei	0.0 %	0 / 6
Mus caroli	0.0 %	0 / 6
Mus cervicolor	0.0 %	0 / 12
Mus musculus	0.0 %	0 / 4
Rattus argentiventer	**5.9 %**	**6 / 102**
Rattus exulans	**3.9 %**	**48 / 1,242**
Rattus losea	**7.0 %**	**6 / 86**
Rattus norvegicus	**20.8 %**	**179 / 860**
Rattus tanezumi	**5.8 %**	**107 / 1,858**
Total	**8.2 %**	**461 / 5,662**

Results:

Litterature review

- Cumulated leptospirosis surveys in murine rodents in Thailand:



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Results:

Complementary sampling

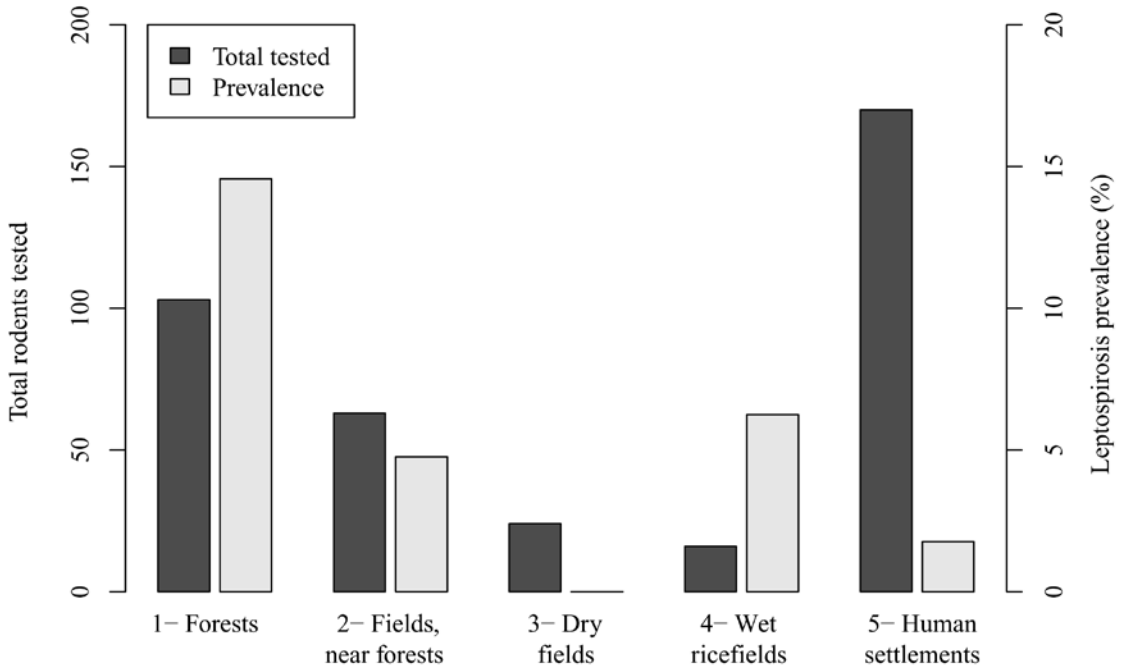
- Results of *Leptospira* spp. detection by mPCR:

Species	Habitat* (anthropization rank)	Pos / Tot (%)
Bandicota indica	**WR (4)**	**1 / 10 (10)**
Bandicota savilei	**DF (3)**	**0 / 24 (0)**
Berylmys berdmorei	**FNF (2)**	**1 / 14 (7.1)**
Berylmys bowersi	**FNF (2)**	**1 / 6 (16.7)**
Chiropodomys gliroides	F (1)	0 / 2 (0)
Hapalomys longicaudatus	F (1)	0 / 2 (0)
Leopoldamys edwardsi	F (1)	0 / 9 (0)
Leopoldamys sabanus	**F (1)**	**10 / 28 (35.7)**
Maxomys surifer	**F (1)**	**4 / 53 (7.5)**
Niviventer fulvescens	**F (1)**	**1 /43 (2.3)**
Rattus andamanensis	**F (1)**	**1 / 9 (11.1)**
Rattus exulans	**HS (5)**	**1 / 57 (1.8)**
Rattus losea	WR (4)	0 / 6 (0)
Rattus norvegicus	HS (5)	0 / 8 (0)
Rattus tanezumi	**HS (5)**	**2 / 105 (1.9)**
Total		**22 / 376 (5.9)**

Results:

Complementary sampling

- Results of *Leptospira* spp. detection by mPCR:



Results:

Complementary sampling

• Results of *Leptospira* spp. detection by mPCR:

- Statistical analysis:

- Different level of exposure or susceptibility for each species.

- Similar prevalences in males (6.3%) and females (5.3%).

- Prevalence in adult rodents (6.6%) nearly twice the prevalence in juvenile ones (3.8%), but not statistically attested (two-tailed Fisher's exact test, $p=0.461$, $p>0.05$).

- GLM: the log-transformed "head and body length" and the habitat ranking entered at $p<0.04$ the model

→ ***larger animals living in less-anthropized habitats have a higher probability to be infected by leptospirosis.***

Conclusion

• Habitats where rodents were collected significantly affect rodent infection.

• Rodents living in forests or at the interface of forested areas and agricultural areas are major carriers of *Leptospira* in Thailand.

→ in agreement with older studies in Malaysia (Smith et al., 1961; Wisseman et al., 1955)

Is there any spillover from wild rodents to commensal species?

→ Some species may act as epidemiological bridge between different types of habitats.

→ Further studies will be necessary to characterize the different leptospires and assess the existence of horizontal transfers.

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Effects of biodiversity changes and implications in health ecology

Acknowledgements

CERoPath project (Dir. Serge Morand)

Post-doctoral “sponsors” at Maison de la Télédétection: